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BEE BUT NOT *BE*: ORAL READING OF SINGLE WORDS IN APHASIA AND ALEXIA

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Abstract—Three studies are reported of the oral reading ability of language-impaired patients. Part of speech and picturability are shown to contribute to a word's readability. In addition, words whose referents can be easily manipulated (*operative* nouns) prove easier to read than matched words whose referents are relatively *figurative*.

Comparisons of reading and naming ability were drawn between aphasic patients and patients clinically diagnosed as alexic. These comparisons suggest that for most aphasics reading and naming are mediated by separate mechanisms, with the ability to read being relatively spared; that alexics without agraphia achieve most success with short words, irrespective of part of speech; that alexics with agraphia achieve most success with picturable nouns, even when these contain more letters. In alexia with agraphia, reading and naming occur at a comparable level and may be mediated by identical or similar cognitive mechanisms.

IF ORAL reading in aphasia simply reflected what remained of the capacity to translate constituent graphemes into sound, then charting this ability would be of scant interest. However, the various ways in which aphasic reading breaks down seem to require a more complexly-based level of analysis [1–3]: witness frequent reports attesting to the role of reference in oral reading, the patient, for example, not being able to read "to be or not to be", but succeeding with "2 bee oar knot 2 bee". Quite likely, even in aphasia, some form of processing or sampling for meaning is carried out, irrespective of the visual or acoustic properties of the words comprising the utterance.

The present report attempts to detail some of the meaning-implicated variables involved in oral reading. These analyses of reading are presented both for aphasia and for those syndromes in which reading appears to be even more impaired than auditory language skills—the two classic forms of alexia [4]. Also examined is the relation between the language-impaired patient's ability to read aloud single words and his ability to name the visually presented referents of these words. Given the interesting manner in which these two processes normally differ [5–8] and the fact that they can be differentially affected by brain damage [9, 10], such a comparison might be expected to underline the critical variables involved—isolating those cognitive dimensions that are common to reading and naming, as well as those unique to each of the two processes. Moreover, the range of oral communication capacities may be elucidated by specifying the contributions of specific linguistic and cognitive factors to oral reading.

Three studies of oral reading were undertaken. The first two studies assessed oral reading of words of different syntactic categories, of different lengths, and of words that differed in terms of the operativity (or manipulability) of their referents [11]. Comparisons were also drawn between oral reading ability and confrontation naming. In contrast to these first studies, where the clinical population consisted primarily of aphasic patients of varying pathology, the third study focused on the reading practices of alexic patients who presented no appreciable aphasia. An attempt was made to differentiate experimentally between the reading performances of patients diagnosed as having alexia with agraphia and those presenting with pure alexia.

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In these studies, the independent variables could be divided roughly into those that reflect descriptive linguistic categorization and those that are primarily of an extralinguistic, cognitive nature. Of special interest within the linguistic domain was whether or not reading would be influenced by the category to which the lexical item normally belonged, that is, by whether the item was a noun, a verb, or a grammatical morpheme. This was investigated in order to determine if the predilection of patients of differing pathologies for certain parts of speech would be reflected in reading performance. Patients with damage in the anterior portion of the left hemisphere favor concrete nouns in their speech [12]; it was hypothesized that this category of words would prove easier for them to read. Patients with lesions in the posterior portions of the left hemisphere favor grammatical particles and a variety of syntactic relations in their speech, which is consequently deficient in specific nouns [13]. Therefore, it was hypothesized that the latter patients would demonstrate a superior performance with parts of speech other than nouns. In each study the thoroughly-analyzed factor of word frequency was controlled for, while length of word was incorporated into the experimental design.

Along more cognitive lines, we were interested in exploring the notion that a subject's interactions with a word's referent might influence the word's readability. Accordingly we focused on the distinction between "operativity" and "figurativity". Operativity refers to the potential for an object to be readily held, manipulated, and to appear to a variety of actions and sensory modalities [11]. In contrast, figurative objects are relatively difficult (or unavailable) to manipulate, not firm to the touch, and known largely through a small set of actions and a single sensory modality. It has been shown [11] that depicted objects which are relatively operative are easier to name than depicted objects of equivalent frequency which are relatively figurative. One purpose of the present studies was to determine whether this trend extends as well to the reading of words that designate these objects. Such a finding would constitute strong evidence that referential or "real-world" considerations contribute significantly to ease of oral reading.

Finally, in order to investigate the errors likely in oral reading, patients were offered four possible alternatives for any word they had been unable to read orally. Examination of these multiple choices documented the relative frequency of visual, auditory, and semantic paralexias [14, 15].

STUDY 1: ORAL READING OF DIFFERENT PARTS OF SPEECH: METHODS

Subjects

The subjects were 38 language impaired patients admitted to the Aphasia Service of the Boston Veterans Administration Hospital. Any patient who could be reliably classified by the clinical staff according to guidelines established in the Boston Aphasia Diagnostic Test [13] as either Broca's aphasics (18 patients), Wernicke's aphasics (6 patients), global aphasics (6 patients), or alexic patients without significant aphasia (8 patients) and who could read at least eight of the words aloud were included in the test. The alexic patients were all agraphic, though the degree of agraphia varied; all but two exhibited mild anomia but this symptom was minimal in comparison to the alexia. Patients with pure anomia were excluded because of the relative intactness of their oral reading capacity. The patients were all right-handed males: their median age was 53 and they were primarily of working-class background.

Materials

The stimuli to be read aloud were 84 common English words divided into seven categories of equal size (12 words per category). The categories were matched in mean frequency* except for grammatical particles, whose frequency was necessarily much higher. The seven categories, each with two associated examples are presented in Table 1. Each word was printed in inch-high letters on index cards.

Table 1. Stimuli in Study 1

Type of word	Example	Range of length in letters
Grammatical particles	*or, at*	2–3
Short picturable nouns	*bee, web*	3
Operative nouns	*hydrant, book*	4–8
Figurative nouns	*stream, mouth*	4–8
Abstract nouns	*death, problem*	4–8
Short non-nouns	*shy, hid*	3
Long non-nouns	*almost, replace*	4–8

For patients who did not succeed in reading a word orally, four choices were provided. One was the correct answer; the second a word drawn from the same category as the target word (semantic confusion); the third a word which rhymed with but did not bear a strong visual resemblance to the target word (acoustic confusion); the last a word which did not rhyme with but bore a strong visual resemblance to the target word (visual confusion). As an example, with the target word *learn*, the confusions were *study* (semantic), *churn* (acoustic) and *lean* (visual): with the target word *shy*, the confusions were *timid*, *die* and *she*.

Procedure

The patient was told that he would be asked to read a number of words aloud. Even with global aphasics, the task becomes evident as soon as the first practice item was displayed and the experimenter waited expectantly. The patient was first given 15 sec in which to read the word aloud; if he had not responded correctly after this period, he was encouraged to make an attempt. If, after another 15 sec, he still had not read the word correctly, he was then given the four choices in a previously determined random order. The choices were spoken aloud, one per second; as each was spoken, one finger was raised in the experimenter's hand. Then the four choices were spoken again and the patient was required to point to that finger of the raised array which corresponded to his choice. The multiple choice procedure was administered in this manner in order to make the patient's choice unambiguous, and in order not to penalize those patients with difficulty in oral expression. No patient proceeded with the test until he had mastered this method of designating a multiple choice.

So that all patients' responses were treated equally, no response was accepted unless it was a clear, unambiguous version of the target word. No semantic or literal paraphasic responses were acceptable. In most cases the task was administered at one sitting; however, if the patient fatigued, or if he required the maximum interval with each item, the testing took place over two days.

Scoring

The number of words from each category which the patient failed was noted and a total error score was thereby computed. In addition the number of each type of error on multiple choice was computed.

RESULTS

Number of errors by subject group and word category

A 4 × 7 (Patient Group × Word Category) analysis of variance with repeated measures on Word Category was performed on number of errors (inability to read the word orally within 30 seconds). This analysis indicated a significant difference in performance across subject group ($F = 9{\cdot}18$, $df = 3, 34$ $P < 0{\cdot}001$); a significant difference among word categories ($F = 14{\cdot}49$, $df = 6, 204$, $P < 0{\cdot}001$); and a significant interaction between these two variables ($F = 2{\cdot}36$, $df = 18, 204$, $P < 0{\cdot}003$).

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* Frequencies were determined from the list of overall appearances in the corpus found in [16]. In Study 1 the mean frequency of words in each category (except the grammatical words) was approximately 110 appearances in the corpus: half the words in each category were drawn from the 100–600 range, the remaining half from the 5–50 range.

An analysis of the effect of word category was also performed on the scores of the subjects within each subject group. Broca's aphasics displayed a highly significant difference across categories ($F = 11{\cdot}48$, $df = 6, 109$, $P < 0{\cdot}001$). The combined group of posterior and global aphasics (whose comprehension level was equivalently poor) also displayed a significant difference across categories ($F = 3{\cdot}66$, $df = 6, 66$, $P < 0{\cdot}004$), as did the alexic patients ($F = 7{\cdot}48$, $df = 6, 42$, $P < 0{\cdot}004$). These analyses indicate that the category of a word makes a crucial contribution to its readability.

The word-reading profiles of each subject group can be seen in Fig. 1, which depicts the percentage of words not read correctly in each category. It can be seen that short picturable nouns were the easiest for all groups, with longer operative and figurative nouns the next easiest. Long non-nouns proved the most difficult category for each subject group, and the remaining three (abstract nouns, grammatical particles, and short non-nouns) also posed substantial difficulties. That operativity made a significant contribution to readability was demonstrated by comparing the number of operative words with the number of figurative words read by each patient. Twenty-six of the 38 patients read more of the operative words correctly ($P < 0{\cdot}03$, binomial distribution).

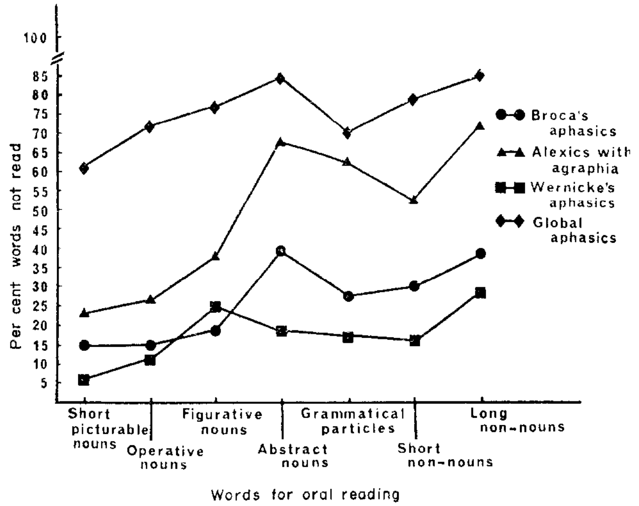

FIG. 1. Percentage of words in each grammatical category which patients were unable to read orally.

In general the order of difficulty was highly similar for the four aphasic groups (Kendall's Coefficient of Concordance $= 0{\cdot}89$, $P < 0{\cdot}01$). It is worth noting, however, that abstract nouns were relatively easier for Wernicke's aphasics (whose language contains many such substantives, like "thing" or "material" [17] while somewhat harder for Broca's aphasics (whose speech features a preponderance of concrete nouns). The Wernicke's aphasics exhibit a non-significant tendency to perform better on the abstract nouns: the Broca's aphasics a highly significant tendency to perform better with the concrete than with the abstract nouns ($F = 16{\cdot}52$, $df = 1, 17$, $P < 0{\cdot}01$).

In summary, for each patient group, the results affirmed the contribution of operativity, brevity, and part of speech (i.e. noun to reading ease). However, as indicated by the significance levels quoted above, the category of word made a more substantial difference for anterior aphasics and for alexic patients (both of whose comprehension is relatively good) than for the global and Wernicke's aphasics, whose comprehension is greatly diminished. Presumably where meaning is less salient, as among those patients with comprehension deficit, the part of speech makes a relatively smaller though still significant contribution. Thus, of the 24 patients with relatively good comprehension, 22 (92 per cent) displayed shorter mean latencies on the three picturable noun categories than on the three non-noun categories: of the 14 patients with relatively impaired comprehension, only 9 (64 per cent) displayed shorter latencies on the picturable nouns.

Table 2. Percentage of visual, acoustic and semantic identification errors in oral reading test

Aphasic group	Visual (%)	Error type Semantic (%)	Acoustic (%)
Wernicke	41	39	20
Global	38	42	20
Anterior	52	26	22
Alexic	53	34	13

Error analysis

The types of errors made on the multiple choice portion of the test were examined. For each aphasic subject group, the vast majority of the errors were either visual or semantic. The percentage of errors is given in Table 2. It can be seen that visual errors were far more common among the patient groups whose comprehension is relatively good. The number of patients in the combined group of patients with good comprehension (anterior and alexic patients) who made more visual than semantic errors was statistically significant ($P < 0{\cdot}05$ binomial distribution), while the number of patients in the combined group of Wernicke and global aphasics with more visual errors did not approach significance. The relatively small number of auditory confusions suggests that the "inner speech form" of the word [18] plays a smaller role in oral reading than in its meaning or dominant visual form.

STUDY 2: READING AND NAMING OF CONCRETE NOUNS: METHOD

Subjects

The subjects were 38 language-impaired subjects, 10 diagnosed as anterior (or Broca's) aphasics, 5 as Wernicke's aphasics, 10 as anomic aphasics, 9 as alexics without significant aphasia, and 8 as "other" (conduction aphasia, transcortical aphasics, mixed aphasia) These patients were comparable to the subjects included in Study 1 in age and social background: however, because of the inclusion of anomic aphasics, the overall severity of aphasia was somewhat less. As in Study 1 the alexic patients all exhibited some agraphia and all but two were mildly anomic in conversation. Twelve of the subjects, including seven alexic patients, had participated in Study 1: at least two weeks intervened between their involvement in the two studies.

Materials

Seventy-two readily depictable objects or elements were included in four familiar scenes devised by an artist. Half of the words were classified as relatively operative, the remaining half as relatively figurative; operative and figurative words were matched in frequency of appearance. The manner of selection of words and scenes was described in an earlier publication [11].

These words were presented under two conditions. In Condition N (Naming) the referents of the words were depicted in the four scenes. Each object or part of object was pointed to and the subject had to name the designated element. In Condition R (Reading) subjects were required to read the actual words, which were printed in inch-high letters on index cards.

Procedure

Subjects were seen in two sessions or series of sessions at least one week apart. For each condition the subject was required to produce the target word within 30 sec; he was encouraged to make an attempt if he had not produced the correct word within the first 15 sec. As in Study 1 the subject was given four choices after 30 sec. Latencies were taken: a score of 4 indicated a correct response within 2 sec; a score of 3 within 5 sec; a score of 2 within 15 sec; a score of 1 within 30 sec. As the number of errors on multiple choice was exceedingly small, the result of the error analysis is not reported here. Half of the subjects received Condition R first, the other subjects Condition N first.

RESULTS

Comparison of reading and naming scores

The results of the study can be seen in Fig. 2. A comparison was made of the speed with which patients provided the correct response on Reading and the Naming conditions. All Wernicke aphasics, all anomic aphasics, five of six Broca's aphasics, and seven of the eight "other" aphasics performed better on Condition R; in most cases the difference was quite substantial. Only the alexic patients displayed a tendency to perform better on Condition N. Of the alexics, six performed better on Condition N, two on Condition R, and one received the same mean latency on each. The overall difference in performance on the two conditions for alexic aphasics was not significant ($F < 1$, N.S.). This finding indicates that patients clinically diagnosed as alexic with agraphia may have significant difficulty in confrontation naming as well as in reading; yet, unlike other aphasic subjects, their naming score is not appreciably lower than their reading score.

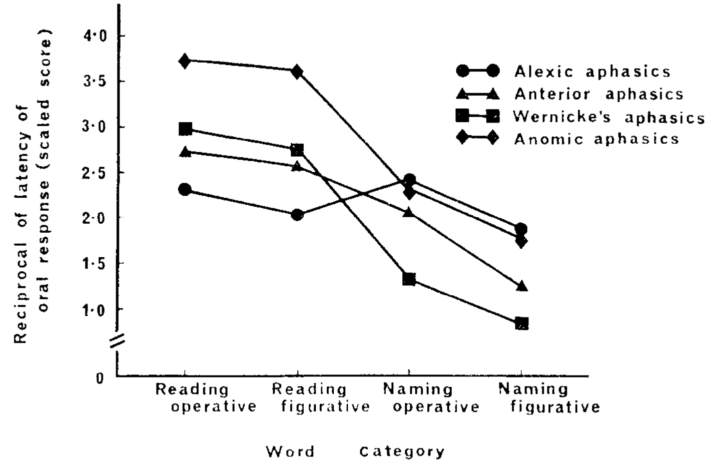

FIG. 2. Mean response latency of aphasic and alexic subjects in tests of reading and naming ability. A scaled latency of 4 indicates a correct response within two seconds; 3 (3–5 sec); 2 (6–15 sec); 1 (16–30 sec).

The performances of the different aphasic groups merit brief comment. The discrepancy between reading and naming scores is especially marked for the Wernicke's aphasics, possibly because the mechanism for decoding graphemes and for articulating words is relatively spared in this group, while lexical organization and storage is significantly impaired. Indeed, when the performances of the Wernicke and anterior groups are compared on the two conditions, a significant interaction obtains between lesion site and testing condition. The Wernicke's performance differs most dramatically from the alexic patients, whose reading score is the lowest (presumably because of impairment of the grapheme-decoding mechanism) but whose naming score is the highest. The reading scores of the anomic aphasics are almost perfect, and their naming scores are comparable to those of the alexic patients, presumably because the lesions of the two groups implicate related cortical regions. Finally the discrepancy between reading and naming scores among the anterior patients is not great, perhaps because language production difficulties affect both tasks.

Operativity of words

As shown in Fig. 2, operative words proved easier to produce that figurative ones in both conditions. On the reading condition, 29 patients (76 per cent) evinced more rapid latencies on the operative items, 3 (8 per cent) displayed more rapid latencies on the figurative items, and 6 (16 per cent) exhibited no difference between the two types of items. Results on the naming test were equally one-sided, with all but eight patients evincing more rapid latencies on the operative nouns.

Other analyses

A comparison of the categories from which the elements were drawn, the kinds of words not read at all, and the errors made on multiple choice yielded little new information (cf. Study 1) [11] and will not be elaborated on here.

STUDY 3: ORAL READING IN ALEXIA: METHOD

Three patients clinically diagnosed as having alexia with agraphia with minimal anomia and the two patients presenting with pure alexia without agraphia each took a special reading test. As a group the patients diagnosed as alexics with agraphia had greatest difficulty in reading letters and were most successful with words; their predominant reading strategy appeared to be a global sampling of the word, trademark, or short phrase. In contrast, the two pure alexics were most successful at reading individual symbols; their preferred strategy was a deciphering of words by means of letter-by-letter spelling. All patients were essentially free of aphasic signs. Included for oral reading were 20 concrete nouns, ranging in length from 4 to 8 letters, and 20 non-nouns (adjectives, prepositions, and conjunctions) containing either two or three letters.

RESULTS

The results of the study are summarized in Fig. 3. For each subject a median latency was computed and the number of words from each category with latencies above and below this median was tallied. Chi-square tests revealed a significant difference for each subject in ease of reading the two categories of words. Specifically, the two patients with pure alexia read the shorter words more rapidly, despite the fact that they were drawn from the parts of speech which usually prove more difficult for aphasic patients to read. In contrast, the three patients having alexia with agraphia read the concrete nouns more rapidly, despite the fact that these words were lengthier.

DISCUSSION

These studies unequivocally document that both a word's syntactic category and aspects of its meaning play a significant role in determining its oral readability. Study 1 indicates that non-nouns are more difficult to read than nouns, and that grammatical particles pose appreciable difficulties to all groups of aphasics, including those who feature such words prominently in their spontaneous speech. Within the category of nouns, those which are picturable and relatively operative prove easier to read orally than those which are abstract

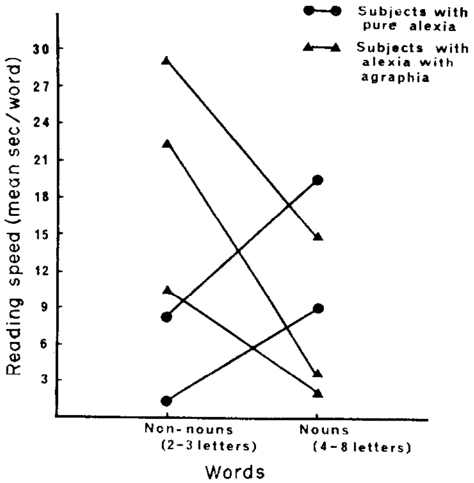

FIG. 3. Mean speed of oral reading of short words which are not nouns and longer words which are nouns in patients presenting with pure alexia or with alexia with agraphia.

and relatively figurative. Length also contributes to ease of reading. Yet, as the scores on grammatical particles testify, brevity alone will not make oral reading easy.

As a corollary, these results undermine the notion that oral reading in aphasia is simply the decoding of a graphic pattern into its component (or "matching") sounds. Instead, it seems likely that, preliminary to an oral response, the word as a whole is sampled at some general cognitive-semantic level.

It had been determined that operativity makes a significant contribution to the ease with which an element is named [11]. Not surprisingly, the effects of operativity are less dramatic in the case of reading. Quite likely, subjects have developed a program for proceeding rather directly from a graphic entity to the spoken word, largely by-passing the numerous linguistic and nonlinguistic associations that might arise a naming task. The existence of such a program would also account for the finding that reading scores are somewhat higher than naming scores. Yet these "associating schemes"—some of which are presumably of an "operative" nature—do not appear to be omitted entirely in the reading process. After all, even when only the printed name of "operative" element was presented, it still proved easier to read than a word denoting a "figurative" element. It may be suggested therefore that even in the course of reading an abbreviated or elliptical recreation of the "occasion of knowing" [19]—an arousal of some scheme associated with the physical object itself may take place.

Obviously the analyses presented here do not tap all the mechanisms underlining oral reading ability. Articulatory difficulties, for example, have not been considered. And it may indeed be that the parallels in reading and naming scores among anterior aphasics reflects pervasive problems in the production of the sounds of language. Yet what is striking is that, over and above these relatively mechanical stumbling blocks, "higher-level" factors can be readily isolated. In this respect, it is of interest to note that even though only a few errors were made on the multiple choice part of the test, there was a pattern to the errors: patients were quite unlikely to make random choices or to choose words which had only an acoustic relation to the target word. Infrequency of acoustic errors suggests that grapheme decoding entails a higher level representation than the less-mediated translation into an acoustic or "inner-speech" form. The principal confusion-items were words which bore a semantic relation to the target word (particularly with patients whose comprehension has been impaired) and words which had a visual resemblance to the target (particularly where understanding is good but an imperfect sampling of the visual configuration occurs).

The present studies document a pattern of reading that is similar in cases of alexia with agraphia and other aphasic disturbances. There are differences, however. Naming performance is better in alexia than in aphasia, while reading performance is equivalent to naming performance. These results suggest that the mechanisms for decoding graphemes into their oral analogue may be selectively impaired among alexics: as a result these patients are dependent upon the overall familiarity and meaningfulness of the visual signal, that symbol being apprehended in an essentially ideographic manner.

Further support for this selective impairment of the reading mechanism comes from the final study in which performances of the principal types of alexic patients were directly compared. Patients having alexia with agraphia more easily read concrete nouns, irrespective of length; patients presenting with pure alexia were best in reading single letters and were aided chiefly by brevity, independent of length or meaning. Thus the former group displayed a clinical picture akin to that of other aphasic patients, while the latter's symptomatology was sharply distinguished from aphasia [20]. These findings constitute a further empirical demonstration of the distinctions first noted by DEJERINE [4] and more recently confirmed with pathological material by several authors [9, 21, 22].

These two varieties of alexia thus bracket the mechanisms of oral reading. The alexic with agraphia has lost the ability to proceed from the visual grapheme to its corresponding individual sounds but retains the capacity to proceed from a familiar visual configuration to its meaning; the pure alexic has retained the capacity to match graphemes with sound but has lost the ability to view the word as a familiar whole, and to derive its meaning and name from its habitual association with a concrete object. The pure alexic, then, has a difficulty essentially remote from aphasia: if the signal could be conveyed to him via another channel his reading difficulties would largely disappear. The alexic with agraphia, on the other hand, epitomizes the difficulty of the aphasic. He has lost the capacity to carry out the mechanics of reading while retaining the penumbra of meaning and the name surrounding more familiar and accessible words. Thus he benefits in particular from nounness and operativity, two factors which apparently elicit his remaining associations and lead him, if indirectly, to the desired oral target. His difficulty with the small grammatical words appears to stem from the fact that, though familiar, these words are likely to have relatively little meaning in isolation; they therefore fail to arouse the articulatory patterns involved in their utterances. Here, then, is a provisional explanation for why the word *bee* poses no problem for most aphasics, while the word *be* is very difficult for all except the patient with pure alexia.

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Résumé—On rapporte trois études sur la capacité de lire à haute voix de malades avec trouble du langage. Les parties du discours et "la picturabilité" contribuent à la légibilité d'un mot. En outre, les mots dont les référents peuvent être aisément manipulés (non *opératifs*) se révèlent plus aisés à lire que des mots appariés dont les référents sont relativement *figuratifs*. On établi les comparaisons de la capacité de lecture et de dénomination entre les malades aphasiques et les malades cliniquement diagnostiqués alexiques. D'après ces comparaisons, il apparaît que chez la plupart des Aphasiques, la lecture et la dénomination sont assurées par des mécanismes séparés, leur capacité de lecture étant relativement épargnée. Les Alexiques sans agraphie font moins d'erreurs avec les mots courts, sans relation avec les parties du discours; Les Alexiques avec agraphie lisent mieux les noms représentables même lorsqu'ils contiennent plus de lettres. Dans l'alexie avec agraphie, la lecture et la dénomination sont à un niveau comparable et peuvent être réalisées par un mécanisme cognitif identique ou similaire.

Zusammenfassung—Es wird von 3 Untersuchungen der Lautlesefähigkeit bei sprachgestörten Patienten berichtet. Dabei zeigt sich, daß Wortart und bildliche Darstellbarkeit zur Lesbarkeit eines Wortes beitragen. Darüber hinaus werden solche Wörter, deren Referenten leicht handhabbar sind (operative Nomina), leichter gelesen als solche ausgewählten Wörter, deren Referenten relativ sinnbildlicher Art sind. Es wurden Vergleiche bezüglich de Lese- und Benenn-Fähigkeit zwischen aphasischen und als Alektiker eingestuften Patienten angestellt.

Diese Vergleiche sprechen dafür, daß Lesen und Benennen für die meisten Aphatiker durch getrennte Mechanismen vermittelt werden, wobei die Fähigkeit zu lesen relativ verschont bleibt, daß Alektiker ohne Agraphie mit kurzen Wörtern am erfolgreichsten sind, unabhängig davon, um welche Wortart es sich handelt, daß Alektiker mit Agraphie mit Nomina darstellbaren Inhalts am erfolgreichsten sind, selbst wenn diese mehr Buchstaben enthalten. Bei der Alexie mit Agraphie spielen sich Lesen und Benennen auf vergleichbarem Niveau ab und können durch identische oder ähnliche kognitive Mechanismen vermittelt werden.